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TITLE OF INVENTION

CLUSTER ASSEMBLY

by

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CROSS-REFERENCES TO RELATED APPLICATIONS

None.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

None.

REFERENCE TO A MICRO-FICHE APPENDIX

None.

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates generally to the field of contact assemblies for switchgear apparatus, and more specifically to cluster assemblies for both low and medium voltage applications which allow a movable circuit breaker to connect to a fixed part of the switchgear.

BRIEF SUMMARY OF THE INVENTION

Switchgear assemblies for both low and medium voltage applications use contact assemblies that allow a movable circuit breaker to connect to a fixed part of the switchgear. The means

of making this connection is accomplished by copper fingers that are spring loaded and which bridge between conductors of uniform geometrical shape including, but not limited to round and rectangular conductors. Many different types of springs are used in these assemblies including compression, tension and leaf styles. For each embodiment of the present invention, the means of retaining the fingers and springs has varied widely as required to satisfy the particular size and geometry of conductor.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is a perspective view of a finger element of an embodiment of the present invention.

Fig. 2 is a perspective view of a finger spring element of an embodiment of the present invention.

Fig. 3 is a perspective view of a resilient finger spring assembly of the finger element depicted in Fig. 1 and the spring element depicted in Fig. 2.

Fig. 4 is a perspective view of a partial assembly of the finger and spring assembly, locator, and guide of an embodiment of the present invention.

Fig. 5 is a side view of disconnected cluster assembly of an embodiment of the present invention.

Fig. 6 is a side view of connected cluster assembly of an embodiment of the present invention.

Fig. 7A is a perspective view of a 12 finger rectangular cluster assembly of an embodiment of the present invention.

Fig. 7B is an end view of typical locator plate for a 12 finger rectangular cluster assembly of an embodiment of the present invention.

Fig. 7C is an end view of typical guide plate for a 12 finger rectangular cluster assembly of an embodiment of the present invention.

Fig. 8A is a perspective view of a 24 finger rectangular cluster assembly of an embodiment of the present invention.

Fig. 8B is an end view of typical locator plate for a 24 finger rectangular cluster assembly of an embodiment of the present invention.

Fig. 8C is an end view of typical guide plate for a 24 finger rectangular cluster assembly of an embodiment of the present invention.

Fig. 9A is a perspective view of a 58 finger rectangular cluster assembly of an embodiment of the present invention.

Fig. 9B is an end view of typical locator plate for a 58 finger rectangular cluster assembly of an embodiment of the present invention.

Fig. 9C is an end view of typical guide plate for a 58 finger rectangular cluster assembly of an embodiment of the present invention.

Fig. 10A is a perspective view of a 20 finger circular cluster assembly of an embodiment of the present invention.

Fig. 10B is an end view of typical locator plate for a 20 finger circular cluster assembly of an embodiment of the present invention.

Fig. 10C is an end view of typical guide plate for a 20 finger circular cluster assembly of an embodiment of the present invention.

Fig. 11A is a perspective view of a 36 finger circular cluster assembly of an embodiment of the present invention.

Fig. 11B is an end view of typical locator plate for a 36 finger circular cluster assembly of an embodiment of the present invention.

Fig. 11C is an end view of typical guide plate for a 36 finger circular cluster assembly of an embodiment of the present invention.

Fig. 12A is a perspective view of a 54 finger circular cluster assembly of an embodiment of the present invention.

Fig. 12B is an end view of typical locator plate for a 54 finger circular cluster assembly of an embodiment of the present invention.

Fig. 12C is an end view of typical guide plate for a 54 finger circular cluster assembly of an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The apparatus of the present invention comprises a primary finger **10** as depicted in Fig. 1. The primary finger **10** is produced by stamping or similar high volume process from high conductivity copper. The primary finger **10** is common to all designs or embodiments of the present invention so that economical high volume production methods can be employed. The primary finger **10** further comprises a predetermined width, a predetermined length, a center point midway along the finger length, two ends, a top side comprising a circular spring locator **12** located at one end of the finger top side, and a bottom side comprising a locator slot **14** located at the end of the bottom side opposite from the end of the finger having the circular spring locator **12** and a guide slot **16** located on the finger bottom at a point slightly off the center point of the finger towards the locator slot **14**. The preferred embodiment of finger **10** is 0.155 inches thick; however a specific thickness is not necessarily determinative of how the finger functions. As shown, for example in Fig. 7C, the slot width **150** in which one or more fingers **10** will be inserted is sized to accommodate the number of fingers desired per slot and the total finger width. The finger end opposite the end of the locator slot **14** is angled at 45 degrees to form a conical or ramped shaped tip **19**, Figs. 1 and 5.

A finger spring **20**, Fig. 2, of an embodiment of the present invention comprises a formed circular end **22,** a deformed convex top side **24**, a deformed concave bottom side **26**, and a foot end **28**, wherein the deformed top and bottom sides define a leaf spring mechanism. The preferred embodiment of finger spring **20** is made of spring steel and is 18 gauge thick, 0.150 inches wide, and about 2 inches long to provide the requisite load contact force in the deformed state. The finger spring **20** is also common to all designs or embodiments of the present invention and again high volume production methods allow for an economical part.

As shown in Fig. 3, the finger **10** and spring **20** are assembled by locating the formed circular end **22** of the spring **20** into the circular spring locator **12** of the finger **10**, aligning the spring leaf so that the spring convex top side **24** bows above the finger top side, and the spring foot **28** rests on the finger top side providing the resilient finger spring assembly **30**.

In order to retain the finger spring assembly **30** and have it cooperate with the fixed side of a conductor, two flat metal plates constructed from non-magnetic steel are used, Figs. 4 - 6. Both plates comprise front and back surfaces which are identically sized by width and length and which have identical geometries. Both plate surfaces further comprise plate edges of a predetermined plate thickness, and have an array of identically

sized and located slots **150**. One of the two plates is a locator plate **60** and the other plate is a guide plate **70**. The locator plate comprises means by which it can be fixedly connected to the fixed part of the conductor **400**.

The locator plate **60** further comprises means to attach to the guide plate **70** other than the resilient finger spring assemblies on certain embodiments of the present invention. For example, where locator and guide plate geometries are rectangular, the means by which the locator plate **60** cooperates with the guide plate **70** further comprises two fixed arms **67** extending at right angles from the locator plate **60** front surface for a predetermined length such that it extends past the guide plate **70**. The guide plate **70** further comprises two notches on each side that the locator plate fixed arms **67** pass through. The dimension between the fixed arms **67** is larger than the distance between the vertical surfaces of the two notches of the guide plate **70**. The clearance resulting from the difference between the two dimensions limits the side-to-side motion of the guide plate **70** and thus the outer ends of each finger **10**. The dimensional height of the fixed arms **67** is also slightly smaller than the dimensional height of the guide plate side notches. Again the clearance between these corresponding elements limits the up and down motion of the guide plate and thus the outer,

tapered tips **19** of the fingers **10**. Limiting the side-to-side and up and down motions of each finger **10** is critical to ensure that each finger **10** aligns with the conductor **200** so that each finger **10** properly engages with the conductor **200** but the clearance also allows for some misalignment between conductors **200** and **400**.

The cluster assembly is held together by the location of the finger slots **14** and **16** in each of the locator plate **60** and the guide plate **70**, respectively, and the action of the finger spring **20** holding them in place. The resilient finger spring assembly position allows sufficient movement of the oppositely opposed resilient finger spring assembly to receive and engage the movable conductor element tapered tip and full element width, and wherein such oppositely opposed pair of resilient finger spring assemblies for rectangular locator and guide plate geometries define a gap distance between the tapered finger assembly edges which is smaller than the width of the movable conductor element. In the case of the circular cluster assemblies and locator/guide plate geometries, Figs. 10A - 12C, the circular array of the resilient finger spring assemblies and the dimensions of the parts both limit the total motion of the fingers relative to the centerline of the assembly but allow for misalignment of the conductor centerlines.

In an embodiment of the present invention, Figs. 4, 5, 8B, and 8C, the locator plate **60** and the guide plate **70** are each 10

gauge thick, and the means by which the locator plate can be fixedly connected to the fixed part of the conductor further comprises locator plate openings **65** and guide plate openings **69** for receiving means to bolt the plate to the conductor **400**. In an embodiment of the present invention using rectangular locator and guide plate geometries, the means by which the locator plate **60** connects to the guide plate **70** further comprises two fixed arms **67** extending at a right angles from the locator plate **60** front surface for a predetermined length towards the locator plate **60** rear surface and beyond, and terminating in connection with the guide plate **70** notched edges. The predetermined length of the fixed arms **67** corresponds to the distance between the finger locator slot **14** and the finger guide slot **16** so that when the locator plate **60** is attached to the guide plate **70,** each finger slot can receive its respective plate when the finger is positioned into one of the array of corresponding plate slots. These locator and guide plates can be manufactured using numerically controlled laser cutting equipment known in the art. This production process easily can vary the plate sizes and shapes to economically produce smaller numbers of parts.

As shown in the partial assembly of an embodiment of the present invention using rectangular locator/guide plate geometries, Figs. 4, 8B, and 8C, after the locator plate **60** has been attached to the guide plate **70** by means of securing the

locator plate arms **67** into the guide plate notches **69**, one finger spring assembly **30** is located in the first slot in the array of plate slots of a partial assembly. The locator slot **14** in the finger bottom is positioned such that the locator plate **60** fits in to the locator slot **14** and holds the spring assembly **30** in place, Figs. 4 - 6. As depicted in Figs. 4 and 5, the leaf spring contacts the guide plate **70** at the top of the respective guide plate slot while the finger guide slot **16** receives the guide plate, wherein the guide plate also secures the spring assembly **30**. The finger guide slot **16** depth is such that the leaf spring is deformed from its free state and therefore holds the finger **10** against the bottom of the respective guide plate slot. With this configuration, Fig. 5, the finger **10** is held so that it is at an approximate 4 degree angle of declination measured from the centerline of the conductor **200** in a disconnected state. In the disconnected state, the conductor centerlines are misaligned. The conductor cross-sections are either round or rectangular; however the cross-section of the conductor **400** to which the locator plate **70** is fixedly attached is the same as the cross-section of the conductor **200** to which the cluster assembly engages. As further depicted in Fig. 5, at this 4 degree angle of declination, the gap between the two fingers is smaller than the width of the conductor **200** to be

received. Once the cluster assembly engages the conductor **200** and is connected, the finger spring **20** further deforms and the finger **10** angle becomes nearly parallel to the centerline of the conductor **200**, Fig. 6, and the conductor centerlines are then aligned.

The tip of the conductor **200** to be received is shaped with corresponding 45 degree angles so that each finger end **19** engages the conductor **200** first at this angled tip, Fig. 5. Once the cluster **40** is connected to the conductor **200,** Fig. 6, the corresponding finger **10** of the finger spring assemblies **30** moves to a parallel position relative to the conductor **200** centerline. The top of the corresponding guide plate **70** slot further causes deformation of the resilient finger spring **20** and each finger **10** now contacts both conductors. The force on each conductor is equal since the guide plate **70** is midway between the raised contact sections of the fingers. The force exerted in the connected cluster is sufficient to ensure good contact between the fingers and the conductors and to allow transfer of electrical current between the two conductors.

Low and medium switchgear require differing levels of rated normal current be carried. These rated currents range from 600 amps to as much as 6,000 amps. The sizes and shapes of conductors to adequately carry this range of current vary and no

single design is possible. A number of possible embodiments are depicted in Figs. 7A - 12C. All of these embodiments use the same primary finger and finger spring components which can be produced in high volume and low cost. Each of the corresponding locator plates and guide plates are shaped and sized to suit the conductor profile employed for the specific current rating and type of circuit breaker. The locator plates and guide plates are manufactured by a process which easily and economically can produce the lower volume variable parts. As depicted in figs. 7A - 12C, it is possible to install more than one resilient finger spring assembly in each plate slot. Up to four resilient finger spring assemblies per slot have been successfully used, though four is by no means a limit. As depicted in Figs 10A - 12C, the circular locator and guide plates do not require attachment means between the plates other than the resilient finger spring assemblies, and the circular guide plates do not require access means to bolt the plate assemblies to the fixed conductor since the guide plate opening itself provides this access. The suitable array of locator/guide plate slots and the number of resilient finger spring assemblies per slot are determined by the current rating desired.

Therefore, the disclosed invention provides cluster assemblies for switchgear which are uncomplicated, use few and easily manufactured parts, achieve a high degree of precision

location and orientation, and eliminate design complexity and tedious assembly procedures. It will be understood that, while presently preferred embodiments of the invention have been illustrated and described, the invention is not limited thereto, but may be otherwise variously embodied within the scope of the following claims.